IRON-ABSORPTION BAND ANALYSIS FOR THE DISCRIMINATION OF IRON-RICH ZONES

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a. Title: Iron-absorption band analysis for the discrimination of iron-rich zones.

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c. Problems relating to progress:

Considerable time and expense have been spent in efforts to reproduce photographically the diazo color-ratio composite which represents the end result of several months of computer processing and analysis. Because subtle variations in color on the composite allow a discrimination of geologic materials not possible on standard ERTS images or composites, faithful photographic reproduction of the truecolors in the composite is essential. Unfortunately, the most important color used for discrimination of mineralized areas is green, one of the most difficult colors to duplicate photographically. Many other color combinations were tried in an effort to replace the green with a more easily reproducible color. However, no other combination of colors provides the discrimination capabilities that our original diazo color composite does.

Bringing all of the imagery and geologymaps to one scale has also been time consuming. None of the computer-produced transparencies are at a known scale. As a result, they had to be projected onto an overlay of playas taken from a geologic map at the desired scale. This procedure

proved less than accurate, however; the photographic paper shrank in the drying process, and the paper on which the geologic map was printed was also found to have become distorted. Finally, a stable mylar overlay of the original map was obtained, as was nonshrinking photographic paper. Even then, the scale of the resulting print varied within the picture because the ERTS view of the earth has a slightly different geometry than a drawn map. The same overlay unfortunately could not be used to scale the standard ERTS images because the negatives were too dense. Several substantial delays in receiving work from the photographic laboratory also hindered progress.

The atmospheric-correction procedure may need revising, as topographic effects are still apparent in the processed imagery. In addition to removing atmospheric interference, this procedure is supposed to remove the topographic effects, which create difficulties in the discrimination of certain rock types.

Results of computer processing carried out on a second tape were not as good as those of the first tape, which was processed by a different computer laboratory. One of the band ratios is at a slightly larger scale than the others, making compositing impossible, and the stretches used are too small.

d. Discussions and plans:

1) Part of the study area in south-central Nevada (Rowan, 1973) will be selected for a more detailed analysis. This will include chemical and mineralogical analyses coupled with visible and near-infrared spectral data collected from aircraft platforms. Fieldwork will be an integral part.

2) Only half of frame 1072-18001 (Goldfield) has been processed and analyzed thus far. Plans included completing the processing of this frame and of two other frames, one of which is adjacent to the Goldfield frame. Evaluation of new processing techniques which aid in discrimination of iron-rich zones and mineralized areas will continue.

3) Histograms of the density ranges of various processed images have been requested but not yet received. Analysis of these will be useful in determining the placement and the amount of computer stretch of the dynamic range of the images. Variations in types of stretches will substantially alter the image depending upon which parts of the density range are more or less enhanced.

4) Major and minor lineaments will be digitized using a grid base and then analyzed by computer to determine such values as mean length, standard deviation, and the density of lineaments per grid cell.

5) Computer analyses will be set up for correlation of particular mineral occurrences with major and minor lineaments, known volcanic centers, circular and elliptical features, earthquake epicenters, and hot springs.

6) Secondary standards of reference on the ground will be set up in order to derive more accurate spectra directly from the processed

images. They might also be used for calculating atmospheric corrections.

e. Results and application:

The radiometric aspects of this project have been concentrated on during this reporting period. A paper describing recent analysis and results is underway. Results show that most of the major rock units and altered areas in the test site in south-central Nevada (Rowan, 1973) can be discriminated on the basis of visible and near-infrared spectral-reflectivity differences recorded at satellite altitude. Digital ratioing of the MSS bands and subsequent stretching to increase the contrast are necessary to enhance these differences.

Although the basic spectral information is contained in the stretched-ratio images, color-ratio composites, especially combinations of three ratio images, appear to be the best means of display for geologic interpretation. Additional time has been spent on finding the best combination of colors and ratios, including compositing of the negatives of the ratio images. The best composite, however, still seems to be original one (MSS 4/5, blue; MSS 5/6, yellow; MSS 6/7, magenta) described by Rowan (1973).

Some of the most important practical limitations on this composite include erroneous identification of basalt as felsic rock where soil has formed on large parts of the basaltic surface and a lack of discrimination thus far of basaltic and andesitic rocks. Vegetative masking of terrain can be troublesome, although the composite shows that light vegetation does allow measurement of the spectral reflectivity of the geologic material in which it grows.

Hydrothermally altered areas appear as anomalous color patterns within the volcanic rocks on the composite. Comparison of known mining district locations and clusters of anomalous colors, ranging from green and dark green to brown and reddish brown, shows good agreement in the widespread Tertiary volcanic rocks. In the Goldfield Mining District, for example, very striking agreement was found between the anomalous green pattern and Ashley's map of the alteration zone. However, the density of anomalies relative to the mines is not as high in the southwestern part of the study area where the alteration and mineralization is associated with intrusion of pre-Mesozoic rocks by Mesozoic granodiorite. Apparently the lower density of color anomalies is related to the less widespread surficial alteration in the pre-Mesozoic rocks than in the Tertiary volcanic rocks. It is noteworthy that, on the basis of a preliminary analysis, only the most highly colored limonitic alteration zones are apparent on the SKYLAB color photographs of the study area.

Although the details of the spectral reflectivity and mineralogical assemblages have not been determined in the altered zones, some general relations appear to be consistent throughout the study area. Limonitic outcrops are green to dark green in this color composite, and with the exception of a slightly ferruginous sandstone, the limonite is associated with oxidation in hydrothermally altered rocks. However, all green areas in the composite are not limonitic. Some green areas, as is well illustrated in the Goldfield Mining District, are essentially limonite-free argillized volcanic rocks. This relationship suggests similar spectral reflectivity for the clay minerals in the argillized rocks and limonite. Reddish-brown areas in the color-ratio composite commonly appear to be unaltered

silica-rich light colored volcanic rocks. Brown areas, though studied in less detail than the other color anomalies, generally seem to be altered light-colored volcanic rocks.

f. Reports:

Rowan, Lawrence C., 1973, Iron-absorption band analysis for the discrimination of iron-rich zones: U. S. Geol. Survey open-file report, 24 p.

g. Changes in operation:

none

h. Changes in standing order forms:

none

i. ERTS Image Descriptor forms:

no changes

j. Data Request forms:

no changes